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ABSTRACT

Cornell University Libraries maintains one central technical services processing department which processes all material for endowed division libraries. It is divided into four functional departments: acquisitions, serials, cataloging, and catalog maintenance. This report is concerned with the latter two functions. The present manual system of cataloging books was analyzed to determine the cost per title. The feasibility and cost effectiveness of installing the Ohio College Library Center (OCLC) on-line computer system for cataloging was then analyzed. The authors recommend implementation of the OCLC system by leasing three terminals with a projected cost savings of $5,000 per year. (Author/SJ)

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EVALUATION OF A COMPUTER-BASED CATALOGING SUPPORT SYSTEM FOR USE BY THE CORNELL UNIVERSITY LIBRARIES

A Project Report

Presented to the Faculty of the Graduate School

of Cornell University in Partial Fulfillment

of the Requirements for the Degree of

Master of Engineering (Industrial)

by

David W. Koehler

Barry N. Shrut

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Summary

The Cornell University Library's central technical services department acquires approximately 70,000 titles each year. Each new book eventually passes through the cataloging department before it is stored on a shelf in one of the physical plants of the library system. In the cataloging department, incoming books are sorted into categories by subject and distributed to teams of professional catalogers. Using a cataloger's worksheet, a book is cataloged, given a call number, and distributed to one of the library plants. The worksheet is then used to produce catalog cards. This involves the typing of an original card and the reproduction of the remaining ones.

To reduce cataloging costs and reduce cataloging time, Cornell library officials have decided to introduce a new computer-based system which is already in operation in some libraries in Ohio. The new system uses cathode ray tube terminals as links to a data base in a computer in Ohio. Information about all titles either cataloged by the libraries using the system or by the Library of Congress are contained in the data base. When a required cataloging record is in the system, the information can be displayed on the screen. This information may be altered to the individual library's specifications. When the library is satisfied with the call number and the general information, it authorizes the production of cards on the high speed printer of the Ohio installation. These cards

are subsequently mailed to the library with an expected delivery time of one to two weeks.

The objective of this project is to provide accurate bases for the Cornell University Libraries to use in evaluating their decision to implement the computer-based system.

Recommendations

We recommend that Cornell University Library's Technical Services Department implement the Ohio College Library Center (OCLC) system by leasing three terminals. When in operation, the new system should save approximately $5000 per annum.

Table of Contents

Acknowledgements		i
Summary		ii
Recommendations		iv
I.	Present System	1
	A. Present System Operation	1
	B. Present System Costs	2
II.	Proposed System	8
	A. Proposed System Operation	8
	B. Use of Proposed System by Cornell University Libraries	12
	C. Expected Annual Cost of Proposed System	14
	D. Processing Efficiency of Proposed System	15
III.	Comparative Evaluation and Recommendations	16
Appendices		19

Present System Operation

Cornell University Libraries maintains one central technical services processing department. Located in Olin Library, the department processes all material for endowed division libraries. It is divided into four functional departments: acquisitions, serials, cataloging, and catalog maintenance. Work processing in the acquisitions and serials departments will not be affected by the advent of an automated cataloging system. Therefore, this report concerns itself solely with the analysis of the cataloging and catalog maintenance functions.

The cataloging department prepares cataloging information for all monographic and thesis materials and all added volumes and copies. There are eight general cataloging sections: Science, Slavic, Germanic, Humanities, Social Sciences, Rare Books and Manuscripts, Arts, and Romance Languages. Each cataloger does descriptive and subject cataloging, classification and shelf-listing, and orders authority cards and cross reference cards when these are needed, for each title cataloged. In addition, there are area cataloging sections which handle materials in their special languages and areas.

The catalog maintenance department presently produces and proofreads copy for all catalog cards. In addition, the department maintains a large dictionary catalog in Olin Library and is responsible for keeping all catalogs on campus up to date.

Present System Costs

A time/cost study of the acquisitions, cataloging, and card production tasks in the technical services department was conducted to provide an accurate picture of present processing requirements. This study provided the following types of information:

1) estimated costs of processing titles using current manual methods.

2) comparative processing costs for titles obtained under two distinct ordering systems--blanket and unit orders.

   Unit order titles require individual order requests for each title. Requests from various segments of the university, after screening by the acquisitions department, are ordered from the publishers.

   Blanket order titles are part of a subscription plan that allows selected publishers to send all titles under certain subject headings. For example, Cornell receives material from major university presses under this agreement. Since Cornell generally will order all the scholarly books in certain subjects areas, the blanket order system simplifies the ordering process and reduces the lag that results in requesting of books that will most likely be requested eventually.

3) percentage of available Library of Congress (LC) copy versus original copy.

   Cornell subscribes to the Library of Congress for cataloging

information. This descriptive cataloging data comes in the form of Library of Congress (LC) cards. When titles arrive for which LC cards are available, the cataloging function is greatly simplified. If there is no LC card corresponding to a particular title, the cataloging department may either wait, anticipating that LC information for that title will arrive in the near future, or may decide to do its own cataloging of the book. In the latter case, the book is given to a professional cataloger who provides what is known as original cataloging.

It is necessary to decide what group of books should be used in the time/cost study. Sampling over a specified time period does not seem advisable since it involves a massive data keeping effort. Even with such a sample, there can be no meaningful projection for yearly flows since arrival of shipments is sporadic. It is concluded that the processing of a single unit order and a single blanket order shipment will provide good estimates for average cost/title.

After the plans for the study had been set, the acquisitions department waited for a book shipment to arrive. A unit order shipment suitable for the study arrived shortly thereafter. There were 134 titles in the unit order shipment. The titles consisted of trade, institution and social publications, of which the vast majority were written in English. The titles generally consisted of works in the humanities, social sciences, and sciences. They had been either selected from Title II cards

(so called because this act of Congress granted the authority for the Library of Congress to print catalog cards), or ordered by college and department librarians on the standard order form. There were some multi-volume works but no monographic series. Based upon examination of some other orders, it appeared that this particular order was a typical representative in terms of titles ordered.

A blanket order shipment arrived one week after processing had begun on the unit order sample shipment. Blanket order titles generally are published in the U.S., Canada, Great Britain, Australia, or South Africa by major university presses (primarily in English) and cover humanities, social sciences, and sciences. This collection included multi-volume works, but no monographic series. This group of titles was somewhat smaller in number (61 titles) than usual, but was typical in subjects, languages, and processing requirements.

Costs per title were calculated using time information obtained during the processing of the unit order and blanket order arrangements of books. After processing the titles, library personnel noted the time required for their specific tasks on flyers which accompanied the titles in the shipment through the technical services department. Since the acquisitions department treated the shipment as a single entity, times for a task included all books in the group. Cataloging required that the shipment be separated so that individual catalogers within cataloging teams, e.g. humanities, social sciences, etc.,

could catalog material within their field. Therefore, for both the unit order and blanket order shipments, each book was tagged with a flyer (a blank strip of paper protruding from the book). Notations for the time required for the cataloging tasks for an individual title were noted on its flyer.

Card production costs were calculated by interpolation from several recent cost studies done by the catalog maintenance department. Both labor and equipment costs were considered as direct costs in card production.

The cost per title figures given in the study assume 2028 total available work hours in a year (39 hrs./wk x 52 wks/yr. =2028 hrs/yr.) A cost study calculated on this basis would be unrealistic since 2028 hours of productive time per worker is never achieved. Such factors as vacations, absenteeism, tardiness, illness, breaks, fatigue, etc. reduce the amount of productive hours available. A number of studies on office and industrial efficiency have shown that 1300 hours represents an average productive hours equivalent per worker per year.

The following table summarizes the equivalent cost per title for all labor costs in the cataloging and card production tasks as well as the card production equipment costs. A detailed breakdown of costs for each task is presented in Appendix A-2, while a description of processing is provided in Appendix A-1.

	Unit Orders	Blanket Orders
Cataloging (Labor)	$1.062	$1.728
Card Production (Labor)	.825	.890
Total Labor Costs	1.887	2.818
Overhead Costs (20%)*	.378	.564
Card Production (Equipment)	.116	.116
Total Cost/Title	$2.381	$3.498

The expected cost of the present cataloging system can be computed using the summary data of the time/cost study. An analysis of incoming materials shows that 80% of all titles arrive under the unit order system, and 20% under the blanket order system. Using this percentage split, the relevant costs are as follows:

Cataloging (Labor)	$1.20
Card Production (Labor)	.84
Card Production (Equipment)	.12
	$2.16

Projecting this cost/title for an expected flow of 40,000 volumes (the volumes that would be processed under the

*Overhead cost treated as percentage of direct labor cost as in Ferdinand F. Leimkuhler & Michael D. Cooper, "Cost Accounting for University Libraries," College and Research Libraries, v. 32, 1971, pp. 449-64.

proposed system) gives an annual cataloging cost of $86,400 under the present system.

In order to compare the efficiency of the present system with that of the proposed system, a computer simulation model was developed. The simulation is designed to estimate the average time that a book takes to go through the cataloging department. Details are given in Appendix A-3. Results of the simulation show that it takes approximately three to four weeks for a book to go through the cataloging department. This means that it takes approximately ten weeks for a book to get to the shelf with all catalog cards filed.

Proposed System Operation

The principal objective of the Ohio College Library Center (OCLC) is to increase availability of library resources for use in educational and research programs of Ohio colleges and universities. The principal economic goal of the Center is to lower the rate of rise of per-student library costs while increasing availability of library resources.*

OCLC furnishes complete bibliographic information to cataloging personnel when they desire it. The use of its services offers a user a reduction in cataloging costs by sharing the cost of cataloging efforts with other schools. It is an on-line computer system which uses cathode ray tube (CRT) terminals in each user library.

Each terminal has its own central processing unit which posseses a memory and logic circuits. It translates all inputs to machine language and connects the terminal to the data base computer, a Xerox Sigma 5, located in Columbus, Ohio. This computer effects the linkage to a user terminal by polling all terminals to see if a request is waiting. After linkage, the information that is displayed on the screen remains there until the next command is given. At present, the average response time (time between terminal input and information retrieval) is approximately two and one half seconds. Response time should not increase significantly with the addition of new terminals.

To add or retrieve records, an indexing scheme based upon

*Cataloging on a Cathode Ray Tube Terminal, "OCLC Newsletter," June 1971.

a hash coded table is used. A number of letters of the author's surname and the title forms a general key for the book. The keyed book is sent to an area in the data storage or to a chained overflow area. The books are also cross-referenced by their LC number (if one exists), facilitating retrieval of LC titles.

To add titles to the data base, the Library of Congress sends MARC (machine readable cataloging) tapes to the OCLC. These tapes contain most of the titles that have been cataloged by the Library of Congress. Other additions come from the user libraries when they enter original cataloging. Approximately forty percent of all book entries are originated by the OCLC user libraries.

In the Cornell University Library the terminals will be used to perform four functions. These are classified as search, input, cataloging, and proofreading. (See Appendix B-1 for flowchart of terminal activities)

Searching on a terminal involves typing the LC number or the book's key on the terminal's keyboard. One or more book titles may appear as a result of the computer search. The searcher notes whether or not the title is contained in the data base and continues on to the next book.

If the book's bibliographic information has not been entered into the data base by the Library of Congress or another member library, it is not found in the initial search

procedure and may be placed on a shelf to be re-searched at a later date. If subsequent searches show that the book still has not been entered into the system, the book must then be cataloged from scratch by the individual library's own personnel. Inputing involves placing the book's bibliographic information in the data base. The cataloger or terminal operator types the information onto the screen directly from the cataloging worksheet. This information is then placed in the terminal's temporary storage for later use.

Cataloging is the operation required when a book's bibliographic information is available in the data base. The terminal operator calls up the record and edits it on the screen. It, too, is then placed in the terminal's temporary storage to be proofread later.

Proofreading involves calling up a book record from the terminal's storage and correcting any mistakes in the original cataloging. Once completed, the proofreader authorizes production of catalog cards, removes the record from the terminal's temporary storage, and sends the record to the permanent computer data base. This cataloging information is added to the data base only if the record is new to the system.

To furnish this service, OCLC charges the member libraries in two ways. The first is for card production--approximately 3.5¢ per card. The second, the weighted title charge, is based upon the number of existing OCLC records utilized by the library. Leasing of the terminals, equipment rentals, and

telephone charges are other costs to be considered by the individual library.

Use of Proposed System by Cornell University Libraries

To implement the OCLC system, Cornell must make certain decisions. Library officials must decide upon the number of terminals to lease, a procedure for scheduling the operation of these terminals, a recycling (re-search) policy for books not found on the first system search, a layout for the department, the flow of work through the department, and the design of new worksheets to facilitate entering bibliographic information.

Presently, only roman-lettered monographic titles are contained within the data base. Estimates reveal that 40,000 of the 70,000 yearly titles processed by the technical services department are written in this graphic which will be conducive to processing by the OCLC system.

We recommend that Cornell lease three terminals (see Appendix B-2). The layout of these terminals should minimize the distance between the terminals and the shelf list, an important cataloger's reference. This will not entail any major changes in the present layout.

Many libraries using the OCLC system have accepted forms designed by other libraries in the system or else have accepted forms that provide only the minimal information required. These forms do not meet Cornell's needs. A single form has been designed (see Appendix B-3) which will serve as

a system document for Cornell Libraries Technical Services Department. The design incorporates all tasks relating to requesting, searching, ordering, processing, cataloging, and inputing. The new form eliminates some of the unnecessary duplication involved when using multiple forms.

The new form has several advantages:

1) It is on a single connected sheet, thus eliminating redundant writing on several forms.
2) The form is divided into areas of predominant usage, e.g. requesting, searching, cataloging, OCLC tagging and inputing, etc.
3) Inclusion of all tasks on one form will alert all users to information requirements of work sections besides their own.

The scheduling of the terminals (see Appendix B-5) and the recycling policy (see Appendix B-6) should be simple and flexible so they can adapt to changes in the system. The proposed flow of work through the new department is discussed in Appendix B-4.

Expected Annual Cost of Proposed System

There are three cost factors to consider when evaluating the expected annual cost of the proposed system. These are equipment rental and card production costs from OCLC, labor cost, and the initial installation cost (see Appendix B-7).

From our study of other libraries, we estimate that there will be a twenty-five percent reduction in the cataloging department's labor cost. The expected annual labor cost is $36,000. The expected annual OCLC charge is approximately $45,700. The total annual cost should be approximately $81,700.

The cost of installation of the terminals and the associated equipment is approximately $2000, an insignificant figure when considering the life of the system.

Processing Efficiency of Proposed System

Another means of comparing the proposed system with the existing system is estimation of the average amount of time required for a title to pass from the acquisition department to the shelf (with all cards filed). To examine the operation of the proposed system and evaluate this in-process time would be made easier if a simulation was performed. Presently, this is a difficult task and any results would be inaccurate. Once in operation, a simulation would be a valuable aid to the Technical Services Department and should be performed when sufficient data is available.

Presently, we can only estimate the average processing time per title. OCLC promises cataloging cards within one week of order. Fifty to sixty percent of all titles should be ready for filing in one week. Other books will be found on subsequent searches or will be cataloged by library personnel. Our estimation of the average processing time per title is 4.4 weeks (see Appendix B-8).

Comparative Evaluation and Recommendations

Our analysis of the present system versus the proposed system shows that a savings should be realized upon conversion to the proposed system. The savings are in annual cataloging costs and operating efficiency.

We recommend that the Cornell University Library's Technical Services Department implement the OCLC system by leasing three terminals. The operation and layout of the system should follow recommendations stated in the previous section. When in operation, the new system should save approximately $5000 per annum. There will be an expected savings in processing time of approximately five to six weeks per title.

There is a potential for savings in other areas of the library which is indirectly attributable to the system. At present, the OCLC system will be used for approximately fifty-seven percent (4/7) of the cataloging department's work. This department does cataloging for most of the physical library plants at Cornell. Some of these plants, e.g. Law, Mann and I & LR, do their own cataloging. To decrease their cataloging costs they could have the central technical services department do their cataloging on the OCLC system. This might require the use of more terminals. To give the administration some idea of the cost involved in taking over other cataloging, a marginal cost study of adding a new terminal is shown in the table below.

Assuming that 13,000 titles are processed on the terminal, of which 9000 would be found in the data base, the costs are as follows:

Terminal Costs:

Leasing	$1200
Card Production (13,000 x .315)	4095
OCLC Charge (9000 x .78)	7020
Service	360
Data Set	660
Additional Telephone Equipment	132
	$13467
Labor Cost (13,000 x .90)	11700
Installation	325
Total Marginal Cost	$25492

Calculations show that Cornell's central facility should charge other libraries approximately two dollars per title to break even. This also assumes that the terminals will be operating at full capacity and there will be no overhead charged for the additional titles processed.

Another area of potential savings is the use of the existing card production equipment. The offset press will be able to meet the cataloging department's card needs with ease after the introduction of the new system. Therefore the idle time of the press could possibly be used by other facilities at Cornell.

An automated system also tends to reduce the variability concerned with the labor force costs. While inflation continues, labor costs inevitably move upward. By substituting the automated system for a segment of the labor force it is possible to hold these costs in check. The precise cost differential will be based on increases in terminal line and maintenance charges versus increases in labor costs.

Appendix A-1

Evaluation of Present System Procedures

This study aims to estimate processing times and costs through the entire technical services department. While the new system is essentially involved with cataloging and catalog maintenance tasks, there may be eventual changes in some procedures within the acquisitions department. We include these considerations of the study of the acquisitions department so that the Library may reevaluate costs vis. a vis. changes in the acquisitions department.

In the acquisitions department unit order books follow a prescribed path. After requests are reviewed, Title II cards are prepared for selection. Departmental librarians come to the acquisitions department once a week to indicate the titles they are requesting. The cards representing the chosen titles are copied to provide a sufficient number for the necessary processing procedures. The cards are then batched and alphabetized according to categories. After these initial preparation steps, the request is searched by one of the department searchers. The searching process consists of finding additional information about the book so that a comprehensive order can be placed. The searching process may discover that the book as requested does not exist, that errors are present on the request form, that the book has been previously purchased and cataloged by the Library of Congress, etc. The searchers utilize numerous sources of bibliographic information, the main one being the Library of Congress catalog.

A reviser screens all requests for possible errors in searching. Those orders which refer to a series of books or volumes are given special

series searching. Then all requests are examined by an editor, whose job it is to prepare them for keypunching. The requests are then keypunched and the computer cards are batched and sent to Langmuir computer center once a week. The remaining request order forms (the forms from which the computer cards were made) are temporarily stored in alphabetical order within the Outstanding Order File (OOF).

Once the requested title arrives in the department, the second stage of processing begins. When titles are received under a unit order, they are prepared for cataloging by the addition of account numbers, fund numbers, and arrival dates of the monograph on the accompanying forms. A processing card and the dealer's invoice for the shipment are sent to the accounting department, and from there the processing card is sent back to computer operations to classify the book as in-process.

The processing of a blanket order in the acquisitions department has many steps similar to those for a unit order. However, by its nature, these steps must take place after receipt of the monograph rather than before. The fact that the record keeping system was derived from the original unit order system may point up some inherent inefficiencies. At this point, it does not appear feasible to develop new accounting programs solely for blanket orders.

Work flow through the catalog department is quite simple compared to the numerous functions in the acquisitions department. There are two types of cataloging involved. For many titles it is possible to find a Library of Congress record for the titles. In this case the cataloger has some of his work completed for him. He takes the cataloging data located in the search step and compares it with the book to see if they agree. If any changes are necessary in the descriptive cataloging,

these are made to assure that it fits the title. The cataloger assigns a call number if an LC number is not accepted as given. The shelf list must be checked so that a conflict does not occur. Finally, the cataloger checks the subject headings and name added entries against authority files, also making additions to the appropriate records in the serial file if the title is part of a series.

If there is no LC copy, the cataloger must do original cataloging. This involves the preparation of a worksheet which is used by the card production personnel to print up catalog cards. After either type of cataloging, there may be revising done. This is merely a check for accuracy by a senior cataloger. This serves as a last check before the cards are prepared.

The catalog maintenance department transforms raw cataloging information into a finished card in the catalog. In order to provide a service at a reasonable cost, this department is probably the most efficiency-minded in the technical services department.

Cataloging copy is initially sorted into processing types. The preparation of copy for press can take several forms. A Xerox machine has been employed extensively to copy existing catalog information. At times LC cards can be used intact, merely by adding a call number. In addition, typists create original cards based on the details of the worksheet. This work is subject to proofreading and correction.

Present library procedures result in the requirement for an average of nine cards per title. Actual card requirements may vary anywhere from several to over twenty. The card stock that Cornell uses is "ten-up", i.e. it provides for ten card images per page. In order to gain some efficiency, a daily batch of copy is sorted by number requirements. Masters are then produced and the card sets printed on the photo-offset press. The cards

are sent to a cutter for finishing.

When the cards return, they must be matched with their original copy. A group of cards for a single title are identical at this point. Subject and title headings are added by typists (this process is referred to as over-typing). Overtyping is an expensive operation due to the individual attention that each card requires. Card sets are then proofread, sorted, and alphabetized for insertion in various catalogs in Olin Library and elsewhere on campus.

Appendix A-2

Present System Cost Study

The wages in this study were calculated by dividing the yearly salary by 2028 hours (e.g. if annual salary is $7098, then hourly wage rate is 7098/2028 or $3.50). Assuming that this worker has a productive work ratio of 64% (1300/2028), it will cost his employer $5.48 for each productive hour or an additional 56% above the base salary rate.

The following tables show the derivation of the costs presented in the body of this report:

TABLE 1 UNIT ORDER ACQUISITION TASKS

(Sample Size: n=134)

Acquisitions Tasks	Wage Rate/hr.	Time	Cost
Prepare Title II cards for selection	2.32	.08	.19
Xerox selected cards	2.74	.67	1.83
Batch and alphabetize	1.85	.37	.68
Search CUL General Catalog and Status List	2.74	6.30	17.26
Series search (22 titles)	2.74	.25	.69
Revise searching	4.80	.97	4.65
Edit for computer input	2.74	.56	1.71
Keypunch	2.74	1.83	5.02
Verify	3.08	.05	.15
File order and search forms	1.85	.72	1.33
Orders mailed	3.08	.05	.15
Books received (IBM cards pulled, invoice checked)	2.74	6.38	17.49
Pull order and search forms	2.74	1.40	3.84
Revise book and search copy	3.46	.82	2.84
Fund and flyer books	2.60	.58	1.52

Cost/title = $62.28/134 = $.465

Productive hour equivalent cost/title = $.465(1.56) = $0.723

TABLE 2 UNIT ORDER CATALOG TASKS

(Sample Size: n=134)
100 LC cataloging
12 original
22 added volumes, serials, etc.

Cataloging Tasks	Wage Rate/hr.	Time	Cost
LC cataloging	3.16	14.98	47.40
LC revising	4.59	1.00	4.59
Original cataloging	4.59	4.58	21.02
Original revising	6.41	.52	3.33

Cost/title = $76.34/112 = $.681

Productive hour equivalent cost/title = $.681(1.56) = $1.062

TABLE 3 UNIT ORDER CARD PRODUCTION TASKS

(Sample Size: n=134)

Card Production and Prefiling Tasks	Wage Rate/hr.	Time	Cost
Sort cataloging copy	3.84	1.07	4.15
Prepare copy for press	3.18	.60	1.91
Proofread prepared copy	3.18	.04	.11
Correct copy	3.18	.02	.05
Sort by card requirement	3.48	.40	1.34
Lay-out and photograph masters	3.00	.54	1.74
Print card sets	3.36	.32	1.08
Maintenance attributable to card reproduction	3.22	1.45	4.68
Match cut cards with copy	3.48	1.47	5.23
Finish card sets	3.18	8.88	28.24
Proofread card sets	4.26	2.01	8.31
Sort and alphabetize	2.80	5.00	14.00

Cost/title = $70.847/134 = $.528

Productive hour equivalent cost/title = $.528(1.56) = $.825

Cost/title of offset/overtyping equipment and supplies = $.116

TABLE 4 BLANKET ORDER ACQUISITION TASKS

(Sample Size: n=63)

Acquisition Tasks	Wage Rate/hr.	Time	Cost
Books displayed for selection	2.74	.12	.33
Search CUL General Catalog and Status List	2.74	3.47	9.50
Series search (8 titles)	2.74	.15	.41
Pull books off review shelf	2.74	.12	.33
Prepare orders for additional copies	2.74	.50	1.37
Edit for computer input and insert flyers	2.74	1.85	5.07
Fund slips	2.74	.33	.91
Revise book and search copy	3.46	1.08	3.74
Keypunch	2.60	2.00	5.20
Verify	2.60	.58	1.51
Match IBM cards with books	2.60	.48	1.25
Slips organized for searching and accounting purposes	2.74	1.67	4.57
Filing	2.74	1.17	3.20
Returns (2 titles)	2.74	.08	.22
Fund Books	2.60	.34	.88

Cost/title = $38.49/63 = $.611

Productive hour equivalent cost/title = $.611(1.56) = $.953

TABLE 5 BLANKET ORDER CATALOG TASKS

(Sample Size: n=61)
40 LC cataloging
21 original

Cataloging Tasks	Wage Rate/hr.	Time	Cost
LC cataloging	3.16	5.09	16.08
LC revising	4.59	.95	4.36
Original cataloging	4.59	8.21	37.68
Original revising	6.41	1.48	9.49

Cost/title = $67.61/61 = $1.11

Productive hour equivalent cost/title = $1.11(1.56) = $1.73

TABLE 6 BLANKET ORDER CARD PRODUCTION TASKS

(Sample Size: n=61)

Card Production and Prefiling Tasks	Wage Rate/hr.	Time	Cost
Sort cataloging copy	3.84	.49	1.87
Prepare copy for press	3.18	1.02	3.23
Proofread prepared copy	3.18	.06	.19
Correct copy	3.18	.03	.08
Sort by card requirement	3.48	.18	.64
Lay-out and photograph masters	3.00	.24	.73
Print card sets	3.36	.15	.49
Maintenance attributable to card reproduction	3.22	.66	2.13
Match cut cards with copy	3.48	.67	2.33
Finish card sets	3.18	4.04	12.84
Proofread card sets	4.26	.92	3.90
Sort and alphabetize	2.80	2.30	6.40

Cost/title = $34.83/61 = $.572

Productive hour equivalent cost/title = $.572(1.56) = $.890

Cost/title of offset/overtyping equipment and supplies = $.116

Appendix A-3

Simulation of the Present System

Collection of data was definitely the most difficult task. Since the cataloging process entails high variation in work scheduling, it was difficult to keep accurate records of processing times. The use of statistics for each cataloger was preferred, but the only available data was statistics of teams of catalogers.

Before the simulation program could be written, several simplifying assumptions had to be made: 1) The cataloging of rare books, Wason collection books, and non-Roman lettered books could be ignored because they will not be handled any differently in the proposed system. 2) The number of personnel within a team was a constant. There is some variance due to absenteeism, vacations, and part-time employees. 3) Cataloging time required per book was assumed normally distributed. 4) The probability of a book being a rush book or an LC book was taken as a fixed percentage.

The six teams mentioned in the program are as follows:

1. Humanities
2. Social Sciences
3. Science and Technology
4. Fine Arts
5. Germanic Languages
6. Romance Languages

The results of the simulation along with other processing information indicate that the time from the cataloging operation to insertion on the shelf and card filing is in the order of ten weeks. Hopefully, the proposed system may provide increased efficiency through speedup of this processing time. The following pages contain a listing of the simulation program.

```
1/*************************************************************
     C  **********/
 /*
     C             */
 /*   THE FCLLOWING ARE VARIABLES, ARRAYS, AND MATRICES OF T
     C  HE         */
 /*PROGRAM WITH THEIR CORRESPONDING USES.
     C             */
 /* TQUE      MATRIX HOLDING QUEUE OF BOOKS FOR EACH TEAM.
     C             */
 /* RQUE      MATRIX HOLDING QUEUE OF RUSH BOOKS FOR EACH TEA
     C  M.         */
 /* SERC      MATRIX HOLDING SERVICE COMPLETION TIMES FOR EAC
     C  H TEAM.    */
 /* R1,--,R5 SEEDS FOR THE RANDCM NUMBER GENERATOR.
     C             */
 /* TYPE      ARRAY HOLDING CLASSIFICATION (LC OR NOT) FOR EA
     C  CH BOOK.   */
 /* ARR       ARRAY HOLDING ARRIVAL TIME OF EACH BOOK.
     C             */
 /* SC        ARRAY HOLDING SERVICE COMPLETION TIME OF EACH B
     C  OOK.       */
 /* TT        ARRAY HOLDING # OF BOOKS DCNE BY EACH TEAM.
     C             */
 /* SIZE      ARRAY HOLDING # OF BOOKS WAITING IN THE QUEUE.
     C             */
 /* WAIT      HOLDS TOTAL WAIT TIME OF ALL THE BOOKS.
     C             */
 /* RUSHT     HOLDS # OF RUSH BOOKS DONE BY EACH TEAM.
     C             */
 /* TOTWAIT   HOLDS TOTAL WAIT TIME OF BOOKS DONE BY EACH TEA
     C  M.         */
 /* TEAMT     HOLDS # OF REGULAR BOOKS DONE BY EACH TEAM.
     C             */
 /* CAT       HOLDS # OF BOOKS DONE PER TEAM.
     C             */
 /* TOT       HOLDS # OF BOCKS WHICH HAVE ARRIVED IN CATALOGI
     C  NG DEP'T.  */
 /* RUSH      HOLDS # OF RUSH BOOKS WHICH HAVE ARRIVED IN CAT
     C  ALOGING    */
 /* TIME      TIME OF SIMULATION.
     C             */
 /* DAY       HOLDS # OF DAYS THAT HAVE PASSED IN MINUTES.
     C             */
 /*
     C             */
 /*   ALL STARTS, FREECS, AND POINTERS ARE USED IN MAINTENAN
     C  CE OF THE */
 /*LISTS.  THEY ARE NOT IMPORTANT TO THE UNDERSTANDING OF TH
     C  E PROGRAM.*/
 /*
     C             */
 /*   MEANS AND SDS ARE THE MEANS AND STD DEVIATIONS OF THE
     C  DISTRIBTNS*/
```

```
/*
    C             */
/*   ALL OTHER VARIABLES ARE USED AS HOLDERS OR CALCULATORS
    C   AND ARE  */
/* ALSO UNIMPORTANT TO THE UNDERSTANDING OF THE PROGRAM.
    C             */
/*
    C             */
/**********************************************************
    C  ***********/
```

```
 (NOFLOW):
1CUL: PROC OPTICNS(MAIN);
 DCL (TQUE(6,999),RQUE(6,20),SERC(1,6)) FLOAT;
 DCL (R1,R2,R3,R4,R5,R6) FLOAT DEC(10);

 DCL (TYPE(2000),ARR(2000),SC(2000),TT(6)) FLOAT;
 DCL DUMMY(6) FLOAT;
 DCL (SIZE(6),RUSHT(6)) FLOAT;
 DCL (TOTWAIT(6),TEAMT(6),STR(6),STT(6),LTR(6),LTT(6)) FLOAT
     C  ;
 DCL (SYS_TIME(6),SERV_TIME(6),Q_SIZE(6)) FLOAT;
 DCL (CAT(6)) FLOAT;
 DCL (SERV(6),QS(6)) FLOAT;
 DCL (START1(1),FREEC1(1),POINT1(1,6)) FLOAT;
 DCL (BOOKT(2000),POINT(2000)) FLOAT;
     TOT=0; RUSH=0;
    DAY=0; WAIT=0;
    TOTL=0;  WTSQ=0;  DUM=0;  SERVT=0;  SERVSQ=0;
    WEEK=1;
    MINT=0;
    HLT=24000;
    DO I=1 TO 6;
       SYS_TIME(I)=0;  SERV_TIME(I)=0;  Q_SIZE(I)=0;
      QS(I)=0;  SERV(I)=0;
       CAT(I)=0;
       STR(I)=0;
       STT(I)=0;
       LTR(I)=0;
       LTT(I)=0;
       TOTWAIT(I)=0;
    DUMMY(I)=0;
         SIZE(I)=0;
    RUSHT(I)=0;
    TT(I)=0;
       TEAMT(I)=0;
    END;
    ST=0;
         TIME=0;
         MEAN1=0;  MEAN2=0;  SD=0;  SD2=0;  CCMP=0;
    A=1; B=6;   /*LIMITS USED FOR FOLLOWING SETUP ROUTINE*/
    CALL SETUP(POINT1,FREEC1,START1,A,B);
    DO J=1 TO 1999;
       PCINT(J)=J+1; END;
    FRC=1; POINT(2000)=0; START=0;
    MEAN1=130;  SD=20;
    R1=.987654321;
    R2=.563245781;
    R3=.963254751;
    R4=.543214251;
    R5=.123456321;
    R6=.864297531;
         A=969/3806;  BI=A+751/3806;  C=BI+330/3806; D=C+334
     C  /3806;
         E=D+687/3806;
```

```
-/*****************************************************************
     C  ***********/
 /*   THIS BLOCK (BEGD) SIGNIFIES THE BEGINNING OF A DAY.  A
     C   NUMBER   */
 /* OF BOOKS ARRIVE FROM ACQUISITIONS AND ARE ADDED TO THE S
     C  YSTEM.    */
 /* THEY ARE THEN ASSIGNED TO A TEAM'S LIST,  THE FIRST BOOK
     C   TO ARRIVE*/
 /* AT AN EMPTY LIST BECOMES A DUMMY BOOK WITH ZERO SERVICE
     C  TIME.     */
 /* THIS IS DONE TO SET UP THE LISTS PROPERLY.
     C            */
 /*****************************************************************
     C  ***********/


-BEGD:
    IF TIME=HLT THEN GO TO FIN;
    CALL NORM(XN,MEAN1,R1,SD);  /*NUMBER OF BOOKS IN THIS DA
     C  Y*/
    DO I=1 TO XN;
       TOT=TOT+1;       /*TOTAL # OF BOOKS IN SYSTEM TO DATE*
     C  /
       CALL TEAM(R2,NT,A,BI,C,D,E);
       TT(NT)=TT(NT)+1;
       SIZE(NT)=SIZE(NT)+1;
       CALL PR(R3,NP);  /*RUSH BOOK=1, REGULAR=2*/
       CALL LCN(R4,NT,LC);    /*LC BOOK=1, REGULAR BOOK=2*/
       IF START=0 THEN START=1;
       IF FRC=0 THEN DO;
         PUT LIST('TOO MANY BOOKS');
         GO TO FIN; END;
       TYPE(FRC)=LC;
    BOOKT(FRC)=NT;
       ARR(FRC)=TIME;
         IF SIZE(NT)=1 THEN DO;
    SC(FRC)=TIME;
    IE=TIME;
    CALL INSERT(SERC,1,FRC,IE,START1,FREEC1,POINT1,SC);
    DUMMY(NT)=DUMMY(NT)+1;
    IC=1;
         IB=START1(IC);
         NUMB=SERC(IC,IB);
    NUMT=BOOKT(NUMB);
         CCMP=SC(NUMB);
         END;
       IF NP=1 THEN DO;
         RUSH=RUSH+1;
         IF LTR(NT)=20 THEN LTR(NT)=1;
         ELSE LTR(NT)=LTR(NT)+1;
    IF STR(NT)=LTR(NT) THEN DO;
       PUT SKIP LIST ('ERROR--NO SPACE RQUE LIST');
       GO TO FIN;  END;
```

```
-/*****************************************************************
     C  ***********/
 /*   THIS BLOCK (BEGD) SIGNIFIES THE BEGINNING OF A DAY.  A
     C   NUMBER   */
 /* OF BOOKS ARRIVE FROM ACQUISITIONS AND ARE ADDED TO THE S
     C  YSTEM.    */
 /* THEY ARE THEN ASSIGNED TO A TEAM'S LIST,  THE FIRST BOOK
     C   TO ARRIVE*/
 /* AT AN EMPTY LIST BECOMES A DUMMY BOOK WITH ZERO SERVICE
     C  TIME.     */
 /* THIS IS DONE TO SET UP THE LISTS PROPERLY.
     C            */
 /*****************************************************************
     C  ***********/


-BEGD:
    IF TIME=HLT THEN GO TO FIN;
    CALL NORM(XN,MEAN1,R1,SD);  /*NUMBER OF BOOKS IN THIS DA
     C  Y*/
    DO I=1 TO XN;
       TOT=TOT+1;       /*TOTAL # OF BOOKS IN SYSTEM TO DATE*
     C  /
       CALL TEAM(R2,NT,A,BI,C,D,E);
       TT(NT)=TT(NT)+1;
       SIZE(NT)=SIZE(NT)+1;
       CALL PR(R3,NP);  /*RUSH BOOK=1, REGULAR=2*/
       CALL LCN(R4,NT,LC);   /*LC BOOK=1, REGULAR BOOK=2*/
       IF START=0 THEN START=1;
       IF FRC=0 THEN DO;
         PUT LIST('TOO MANY BOOKS');
         GO TO FIN; END;
       TYPE(FRC)=LC;
    BOOKT(FRC)=NT;
       ARR(FRC)=TIME;
         IF SIZE(NT)=1 THEN DO;
    SC(FRC)=TIME;
    IE=TIME;
    CALL INSERT(SERC,1,FRC,IE,START1,FREEC1,POINT1,SC);
    DUMMY(NT)=DUMMY(NT)+1;
    IC=1;
         IB=START1(IC);
         NUMB=SERC(IC,IB);
    NUMT=BOOKT(NUMB);
         CCMP=SC(NUMB);
         END;
       IF NP=1 THEN DO;
         RUSH=RUSH+1;
         IF LTR(NT)=20 THEN LTR(NT)=1;
         ELSE LTR(NT)=LTR(NT)+1;
    IF STR(NT)=LTR(NT) THEN DO;
       PUT SKIP LIST ('ERROR--NO SPACE RQUE LIST');
       GO TO FIN;  END;
```

```
      IF STR(NT)=0 THEN STR(NT)=1;
      IE=LTR(NT);
      RQUE(NT,IE)=FRC;
    END;
    ELSE DO;
      IF LTT(NT)=999 THEN LTT(NT)=1;
      ELSE LTT(NT)= LTT(NT)+1;
IF STT(NT)=LTT(NT) THEN DO;
    PUT SKIP LIST ('ERROR--NO SPACE TQUE LIST');
    GO TO FIN;  END;
      IF STT(NT)=0 THEN STT(NT)=1;
      IE=LTT(NT);
      TQUE(NT,IE)=FRC;
    END;
    FRC=POINT(FRC);
END;
MINT=MINT+480;
DAY=DAY+1;
DO I=1 TO 6;
    QS(I)=QS(I)+SIZE(I);
END;
GO TO SYNCH;
```

```
-/*************************************************************
     C  ***********/
 /*   THIS BLOCK (BKCP) IS CALLED WHEN A TEAM FINISHES A BOO
     C  K.  THE    */
 /*NECESSARY STATISTICS ARE CALCULATED AND THE BOOK IS REMOV
     C  ED FROM    */
 /* THE SYSTEM.  THE NEXT BOOK FROM THE TEAM'S LIST IS TAKEN
     C   FROM THE */
 /* SHELF AND BEGINS SERVICE.  FINALLY, THE NEXT BOOK TO BE
     C  FINISHED  */
 /* IS FOUND.
     C            */
 /*************************************************************
     C  ***********/


-BKCP:
    WT=TIME-ARR(NUMB);
    TOTWAIT(NUMT)=TOTWAIT(NUMT)+WT;
    WAIT=WAIT+WT;
    TOTL=TOTL+1;
    WTSQ=WTSQ+(WT**2);
    START=PCINT(NUMB);
    PCINT(NUMB)=FRC;
    CAT(NUMT)=CAT(NUMT)+1;
    FRC=NUMB;
        SIZE(NUMT)=SIZE(NUMT)-1;
    CALL REMOVE(SERC,1,START1,FREEQ1,POINT1);
 BUILD:
    IF STR(NUMT)>0 THEN DO;
    NUMB=STR(NUMT);
    NUMB=RQUE(NUMT,NUMB);
    RUSHT(NUMT)=RUSHT(NUMT)+1;
    IF STR(NUMT)=20 THEN STR(NUMT)=1;
        ELSE STR(NUMT)=STR(NUMT)+1;
    IF ((STR(NUMT)=LTR(NUMT)+1) | ((STR(NUMT)=1) & (LTR(NUMT
     C  )=20)))
       THEN DO;
         STR(NUMT)=0;  LTR(NUMT)=0;  END;
    END;
    ELSE DO;
    IF STT(NUMT)=0 THEN GO TO EMPTY;
    NUMB=STT(NUMT);
    NUMB=TQUE(NUMT,NUMB);
       TEAMT(NUMT)=TEAMT(NUMT)+1;
       IF STT(NUMT)=300 THEN STT(NUMT)=1;
         ELSE STT(NUMT)=STT(NUMT) +1;
    IF ((STT(NUMT)=LTT(NUMT)+1) | ((STT(NUMT)=1) & (LTT(NUMT
     C  )=20)))
       THEN DO;
         STT(NUMT)=0;  LTT(NUMT)=0;  END;
    END;
    LC=TYPE(NUMB);
    CALL SERVICE(LC,NUMT,MEAN2,SD2);
```

```
-/*************************************************************
     C  ***********/
 /*   REPORT PRINTS OUT ALL DESIRED STATISTICS IN A READABLE
     C   FORM.    */
 /*************************************************************
     C  ***********/


 REPORT: PUT PAGE;
         PUT EDIT('STATISTICS FOR WEEK',WEEK)(LINE(5),COL(55
     C  ),A,F(3));
         PUT SKIP(5) EDIT('TEAM STATISTICS  (TIME IN MINUTES
     C  )')
               (COL(10),A);
         PUT SKIP(0) EDIT('____ __________')(COL(10),A);
       DO I=1 TO 6;
         PUT SKIP(2) EDIT('TEAM ',I)(COL(10),A,F(1));
         SYS_TIME(I)=TOTWAIT(I)/(CAT(I)-DUMMY(I));
         SERV_TIME(I)=SERV(I)/(CAT(I)-DUMMY(I));
         Q_SIZE(I)=QS(I)/(DAY*2);
         PUT SKIP;
         PUT EDIT('AVERAGE TIME IN CATALOG DEPT/BOOK IS',SYS
     C  _TIME(I))
               (COL(10),A,F(8,2));
         PUT EDIT('AVERAGE CATALOGING TIME/BOOK IS',SERV_TIM
     C  E(I))
               (COL(10),A,F(7,2));
         PUT EDIT('AVERAGE QUEUE SIZE IS',Q_SIZE(I))(COL(10)
     C  ,
               A,F(7,2));
       END;
         PUT SKIP(5) EDIT('TOTAL DEPARTMENT STATISTICS',
               '(TIME IN MINUTES)')(COL(10),A,X(2),A);
         PUT SKIP(0) EDIT('_____ __________ __________')(COL
     C  (10),A);
         DO I=1 TO 6;
             DUM=DUM+DUMMY(I);
         END;
         BOOKS=TOTL-DUM;
         DEPT_TIME=WAIT/BOOKS;
         SQUARE=(WTSQ-(BOOKS)*(DEPT_TIME**2))/(BOOKS-1);
         FACTOR=1.96*SQRT(SQUARE/BOOKS);
         LO=DEPT_TIME-FACTOR;
         HI=DEPT_TIME+FACTOR;
         PUT SKIP(2) EDIT('AVERAGE TIME IN CATALOG DEPT/BOOK
     C   IS',
               DEPT_TIME)(COL(10),A,F(8,2));
         PUT SKIP EDIT('95% CONFIDENCE INTERVAL FOR MEAN IS'
     C  ,
               LO,'--',HI)(COL(10),A,F(8,2),A,F(8,2));
         DEPT_TIME=SERVT/BOOKS;
         SQUARE=(SERVSQ-BOOKS*DEPT_TIME**2)/(BOOKS-1);
         FACTOR=1.96*SQRT(SQUARE/BOOKS);
         LO=DEPT_TIME-FACTOR;
```

```
   CALL NORM(ST,MEAN2,R5,SD2);

        SC(NUMB)=TIME+ST;
   SERV(NUMT)=SERV(NUMT)+ST;
   SERVSQ=SERVSQ+(ST**2);
   SERVT=SERVT+ST;
   IE=SC(NUMB);
   CALL INSERT(SERC,1,NUMB,IE,START1,FREEC1,POINT1,SC);
   IF NUMB=0 THEN DO;
   PUT LIST('ERROR IN INSERT');
   GO TO FIN;
    END;
EMPTY:
   IC=1;
   IB=START1(IC);
   IF IB=0 THEN DO;  /*ALL QUEUES EMPTY*/
      TIME=MINT;
      GO TO END_DAY;  END;
   NUMB=SERC(IC,IB);
   NUMT=BCCKT(NUMB);
        COMP=SC(NUMB);
   GO TO SYNCH;
```

```
     HI=DEPT_TIME+FACTOR;
     PUT SKIP(2) EDIT('AVERAGE CATALOGING TIME/BOOK IS',
C    DEPT_TIME)
          (COL(10),A,F(7,2));
     PUT SKIP EDIT('95% CONFIDENCE INTERVAL FOR MEAN IS'
C    ,
          LO,'--',HI)(COL(10),A,F(8,2),A,F(8,2));
     PUT PAGE;
WEEK=WEEK+1;
     GO TO BEGD;
```

```
-/*************************************************************
     C  ***********/
 /*   END_DAY CALCULATES THE QUEUE SIZE AT THE END OF EACH D
     C  AY FOR    */
 /* EACH TEAM.
     C            */
 /*************************************************************
     C  ***********/

-END_DAY:
    DO I=1 TO 6;
       QS(I)=QS(I)+SIZE(I);
    END;
    IF DAY=(5*WEEK) THEN GO TO REPORT;
    GO TO BEGD;
-/*************************************************************
     C  ***********/
 /*   SYNCH ROUTES THE PROGRAM TO THE NEXT EVENT WHICH IS TO
     C   OCCUR.   */
 /*************************************************************
     C  ***********/


-SYNCH:
    TIME=MIN(MINT,COMP);
       IF TIME=MINT THEN GO TO END_DAY;
    GO TO BKCP;
 /*************************************************************
     C  ***********/
```

```
/*                    ***LIST PROCESSING ROUTINES***
    C                */
/*INSERT--PROVIDES FOR PLACING AN ELEMENT INTO A LIST.  THE
    C    FIRST     */
/*FREE COLUMN (FREEC) IS THE CELL INTO WHICH THE ELEMENT IS
    C    PLACED    */
/*START(A) MARKS THE FIRST ELEMENT IN THE LIST.  AN ATTRIBU
    C   TE IS      */
/*GIVEN A RELATIVE PRIORITY NUMBER WHICH IS COMPARED TO PRI
    C   ORITIES OF*/
/*LIST ITEMS SO THAT THE NEW ELEMENT CAN BE PLACED PROPERLY
    C   .          */
/*REMOVE--AN ELEMENT IS TAKEN OFF THE LIST.  THE SECOND CEL
    C   L IN THE   */
/*LIST BECOMES THE FIRST AS THE PREVIOUS FIRST IS REMOVED A
    C   ND PLACED */
/*AT THE HEAD OF THE FREE CELL LIST.
    C                */
/*SETUP--LISTS ARE SET UP WITH THE NECESSARY NUMBER OF CELL
    C   S.          */
/*POINTERS ARE INITIATED FOR THE LISTS.
    C                */
/*****************************************************************
    C   ***********/

INSERT: PROC(LIST,A,NM,RM,START,FREEC,POINT,PT);
   DCL RM FIXED;
      DCL (POINT(*,*),LIST(*,*),FREEC(*),START(*),PT(*)) FL
    C   OAT;
   IF FREEC(A)=0 THEN DO; NM=0; RETURN; END;
   K=FREEC(A);FREEC(A)=POINT(A,K);
   LIST(A,K)=NM; PT(K)=RM;
        IF START(A)=0 THEN DO;
      START(A)=1; POINT(A,1)=0; FREEC(A)=2;
        RETURN; END;
        B=0;
        M=START(A);
BG:    L=POINT(A,M);
        IF L=0 THEN DO;
        IF RM>=PT(M) THEN DO;
            POINT(A,K)=0; POINT(A,M)=K;
        END;
        ELSE DO;
            POINT(A,M)=0; POINT(A,K)=M;
        IF B=0 THEN DO;
            START(A)=K;  END;
        ELSE DO;  POINT(A,B)=K;
        END;  END;
        RETURN; END;
        IF RM < PT(M) THEN DO;
        IF M = START(A) THEN GO TO FIRST;
        POINT(A,B) = K; POINT(A,K) = M; RETURN; END;
      B=M; M=L; GO TO BG;
FIRST:
```

```
      POINT(A,K)=M; START(A)=K; RETURN;
        END INSERT;
REMOVE: PROC(LIST,A,START,FREEC,POINT);
        DCL (LIST(*,*),POINT(*,*),START(*),FREEC(*)) FLOAT;
        L=START(A);START(A)=POINT(A,L);
        POINT(A,L)=FREEC(A); FREEC(A)=L;
        END REMOVE;
SETUP:  PROC(POINT,FREEC,START,ISIZE,JSIZE);
        DCL POINT(*,*),FREEC(*),START(*) FLOAT;
        DCL (ISIZE,JSIZE) FLOAT;
        DO I=1 TO ISIZE;
        DO J=1 TO(JSIZE-1);
        POINT(I,J)=J+1;
        END; END;
        DO I=1 TO ISIZE;
        POINT(I,JSIZE)=0;
        END;
        DO I=1 TO ISIZE;
        FREEC(I)=1; START(I)=0;
END SETUP;
```

```
-/*   TEAM SENDS THE BOOK TO THE PROPER TEAM.
     C                */

 TEAM: PROC(R,NT,A,BI,C,D,E);
         DCL R FLOAT DEC(10);
         R=RAND(R);
         IF (R>A) THEN GO TO SS;
         NT=1;  RETURN;
 SS:     IF (R>BI) THEN GO TO SCI;
         NT=2;  RETURN;
 SCI:    IF(R>C) THEN GO TO FA;
         NT=3;  RETURN;
 FA:     IF (R>D) THEN GO TO G;
         NT=4;  RETURN;
 G:      IF (R>E) THEN GO TO ROM;
         NT=5;  RETURN;
 ROM:    NT=6;  RETURN;
         END TEAM;
```

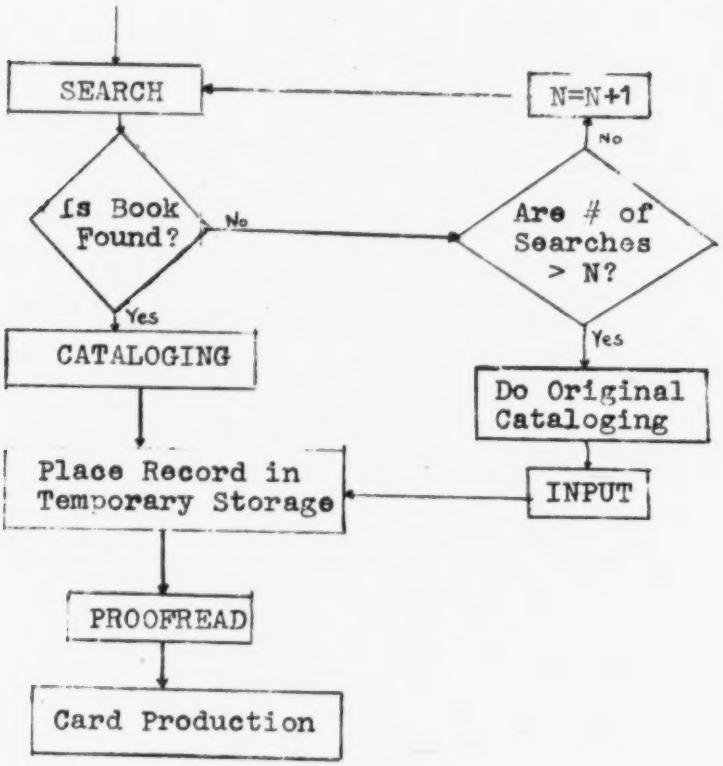
```
/*                        ****NORMAL GENERATION****
    C                */
/*FOR UNIFORM RANDOM NUMBERS ON (0,1) THE MEAN IS 1/2 AND T
    C  HE            */
/*VARIANCE IS 1/SQRT(12).  THEREFORE TO GENERATE RANDOM VAR
    C  IATES         */
/*WITH THE STD. NORMAL DISTRIBUTION HAVING ZERO MEAN AND UN
    C  IT            */
/*VARIANCE IT IS CONVENIENT TO CHOOSE N AS 12, SINCE THE ST
    C  D. DEV. OF*/
/*THE SUM OF 12 RANDOM NUMBERS IS 1.  THIS IS PROBABLY A SU
    C  FFICIENTLY*/
/*LARGE N SO THAT THE DISTRIBUTION OF THE SUM IS APPROXIMAT
    C  ELY A         */
/*NORMAL DISTRIBUTION.  TO OBTAIN ZERO MEAN WHEN N IS 12, 6
    C  IS            */
/*SUBTRACTED FROM THE SUM OF THE RANDOM NUMBERS.  WITH N=12
    C  , THE         */
/*PROCEDURE FOR GENERATING A STANDARD NORMAL RANDOM VARIATE
    C  R IS TO  */
/*SUM(1 TO 12)XI-6, WHERE THE XI'S ARE RANDOM NUMBERS.  NOR
    C  MAL           */
/*VARIATES S WITH DIFFERENT MEAN, M, AND STANDARD DEVIATION
    C  , D, MAY  */
/*BE OBTAINED BY:  S=M+(D*R).
    C                */
      NORM: PROC(N,M,I,D);
      DCL I FLOAT DEC(10);
      DCL (N,M) FLOAT DEC(6);
          R=0; W=0;
          DO W=1 TO 12;
              I=RAND(I);
              R=R+I;
          END;
          R=R-6;
          N=M+(D*R);
          N=FLOOR(N+.5);
      END;

-/*   PR FINDS THE PRIORITY (RUSH OR NOT) OF THE BOOK.
    C                */

 PR: PROC(R,NP);
      DCL R FLOAT DEC(10);
      R=RAND(R);
      IF (R<.063) THEN DO;
          NP=1;
          RETURN;   END;
      NP=2;
      END PR;

-/*   LCN SETS THE TYPE OF THE BOOK (L.C. OR NON-L.C.).  THE
    C  SE ARE    */
 /*DEPENDENT UPON THE TEAM.
```

```
     C             */

LCN:  PROC(R,NT,LC);
        DCL R FLOAT DEC(10);
        R=RAND(R);
        IF (NT=1) THEN DO;
            IF (R<.77) THEN DO;
                LC=1; RETURN;  END;
                LC=2;  RETURN;  END;
        IF (NT=2) THEN DO;
            IF (R<.66) THEN DO;
                LC=1; RETURN;  END;
                LC=2;  RETURN;  END;
        IF (NT=3) THEN DO;
            IF (R<.65) THEN DO;
                LC=1; RETURN;  END;
                LC=2;  RETURN;  END;
        IF (NT=4) THEN DO;
            IF (R<.65) THEN DO;
                LC=1; RETURN;  END;
                LC=2;  RETURN;  END;
        IF (NT=5) THEN DO;
            IF (R<.81) THEN DO;
                LC=1; RETURN;  END;
                LC=2;  RETURN;  END;
        IF (NT=6) THEN DO;
            IF (R<.66) THEN DO;
                LC=1; RETURN;  END;
                LC=2;  RETURN;  END;
        END LCN;
-/*   SERVICE FINDS THE REQUIRED SERVICE TIME FOR THE BOOK.
     C   IT IS    */
 /* DEPENDENT UPON THE TEAM AND THE TYPE OF THE BOCK.
     C             */

 SERVICE: PROC(LC,NT,MEAN,SD);
        IF LC=1 THEN DO;
            IF NT=1 THEN DO;
            MEAN=21.82;
            SD=3.89;
            RETURN;    END;
            IF NT=2 THEN DO;
            MEAN=41.42;
            SD=5.07;
            RETURN;    END;
            IF NT=3 THEN DO;
            MEAN=45.22;
            SD=6.23;
            RETURN;    END;
            IF NT=4 THEN DO;
            MEAN=41.79;
            SD=5.97;
            RETURN;    END;
            IF NT=5 THEN DO;
```

```
            MEAN=35.86;
            SD=3.17;
            RETURN;     END;
            IF NT=6 THEN DO;
            MEAN=32.96;
            SD=4.46;
            RETURN;     END;
        END;
        IF LC=2 THEN DO;
            IF NT=1 THEN DO;
            MEAN=100.00;
            SD=9.78;
            RETURN;     END;
            IF NT=2 THEN DO;
            MEAN=150.97;
            SD=17.64;
            RETURN;     END;
            IF NT=3 THEN DO;
            MEAN=98.87;
            SD=12.34;
            RETURN;     END;
            IF NT=4 THEN DO;
            MEAN=107.59;
            SD=8.92;
            RETURN;     END;
            IF NT=5 THEN DO;
            MEAN=203.48;
            SD=25.39;
            RETURN;     END;
            IF NT=6 THEN DO;
            MEAN=28.98;
            SD=3.74;
            RETURN;     END;
        END;
        END SERVICE;

-FIN:
    END CUL;
*DATA
```

Appendix B-1

Flowchart of Terminal Functions:



Appendix B-2

Terminal Requirements

Assumptions:

1) 40,000 titles per year will be handled by the new system.

2) 70% of all titles searched will be found in the data base.

3) The possibility exists that books other than those searched on the system could be input into the data base. We will use 6,000 titles as a maximum.

4) There will be a maximum of four searches.

5) Terminal usage rates as estimated from other OCLC libraries will be as follows:

Input	10 titles per hour
Searching	30 titles per hour
Cataloging	15 titles per hour
Proofreading	20 titles per hour

6) Estimate of effective working hours per year is as follows:

a) 250 total working days per year.

b) terminals in operation twelve hours per day.

c) terminals down approximately five per cent of the time.

d) training on the terminals will take approximately ten per cent of the usable time on the terminals.

This gives a total of approximately 2,520 effective hours/year.

Results:

Input	19,000 titles at 10 titles/hour	1900
Search	75,000 titles at 30 titles/hour	2500
Catalog	27,000 titles at 15 titles/hour	1800

Proofreading	19,000 titles at 20 titles/hour	950
Total	7150 hours required	
	2.84 terminals required	

Therefore three terminals should be sufficient to meet the needs of the library.

Appendix B-3

Forms Design

Design Factors:

The first step in the design of the form was a determination of criteria to be applied. Personnel from the technical services departments listed a set of design factors to be considered. Several of these factors were, by their very nature, in slight conflict. The final form design represents an attempt to optimize the design criteria (with certain compromises by the departments).

1) Insertable into a standard typewriter with spacing of lines to accommodate standard typewriter spacing.
2) Form control holes at both ends.
3) Continuous printed form.
4) Size standard with respect to commercial filing equipment--
   3 x 5, 4 x 6, IBM card size, etc.
5) Readable print.
6) Sufficient space allowances for all items.
7) Compatible with various writing implements--pencil, pen, typewriter.
8) Information placed to efficiently accommodate use by:
   a. requester
   b. searcher
   c. reviser
   d. dealer assigner
   e. computer input editor
   f. keypuncher
   g. cataloger
   h. OCLC input operator

9) Coding must be visually distinct for minimum OCLC standards; include tags for OCLC input.

10) Standardized coding for files and reference tools.

11) Data conformity for all types of material--monographs, monographic serials, serials.

Forms Analysis:

It was important to group information on the form by function to provide for eight different users. An effort was made to keep sets of information in areas logically grouped by function. Forty-five distinct informational areas were involved.

Starting with a blank 6 1/2" x 7 3/8" piece of paper, informational areas were placed on the form. Space requirements for information areas were given, but could be varied within a certain range of acceptability, thus taking the design problem out of the realm of a fixed size or "jig-saw" type optimization. The final space allotments were, in most cases, adjusted from previous forms by empirical observations in order to accommodate the vast majority of cases.

The design was arrived at by means of iterative optimization. This technique starts with the design of a feasible solution; and at each step, finds a better solution. This is repeated for a finite number of times. The means of measuring whether or not a solution is better than the previous one is the following algorithm:

For each of the eight tasks, a sum of field crossings involved in the sequential performance orders was calculated. For example, a requester will generally first write the author then the title. Since these fields

are adjacent on the form (see Figure B-1), there are no (0) field crossings. If performance of a task involves looking at Account No. and then at Searcher No. there would be four (4) field crossings. Totaling the sums for all tasks gives a single number which can be compared at each iteration. If a new design gives a lower sum than a previous one, then the new design can be used. Often the best clue for a change was merely visual.

The new form will fulfill the major design requirements listed above. In testing, the form proved that it provided adequate space in over 95% of the cases. There will be a certain percentage of titles which will require more space for cataloging data. Titles requiring long contents notes and long corporate entries will require an overflow sheet for additional information. Also there will be titles for which the bibliographic data supplied by the requester will demand so much revision by the cataloger that a new form will have to be filled out. The form can be used for a large percentage of titles; its use will eliminate steps in processing and help the Technical Service Department establish an efficient and economical work routine when using the OCLC system.

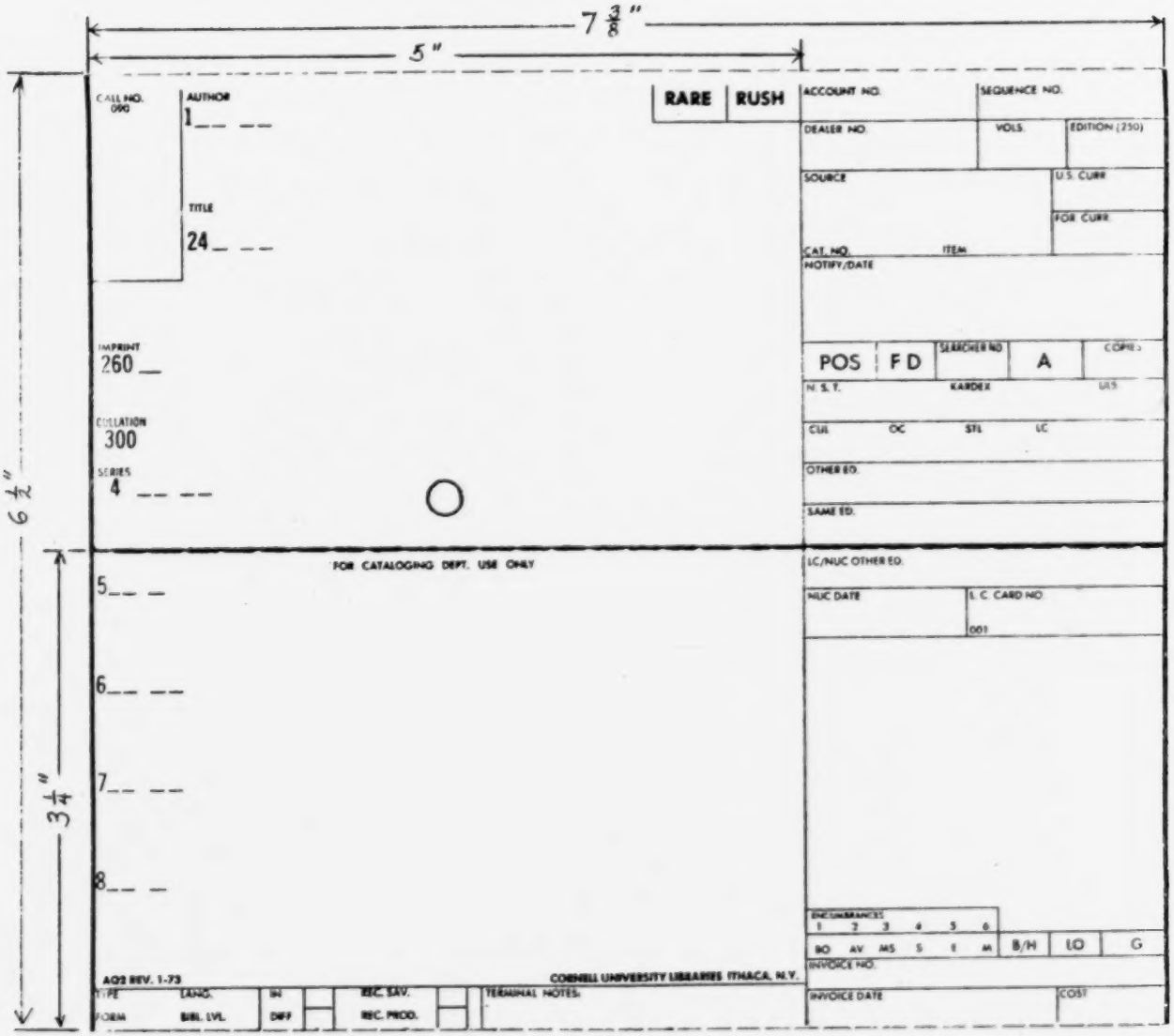

7 3/8"
5"
6 1/2"
3 1/4"
CALL NO.
090
AUTHOR
1__ __
TITLE
24_ __
IMPRINT
260__
COLLATION
300
SERIES
4 __ __
RARE
RUSH
ACCOUNT NO.
SEQUENCE NO.
DEALER NO.
VOLS.
EDITION (250)
SOURCE
U.S. CURR.
FOR. CURR.
CAT. NO.
ITEM
NOTIFY/DATE
POS
FD
SEARCHER NO.
A
COPIES
N. S. T.
KARDEX
LOS
CUR.
OC
STL
LC
OTHER ED.
SAME ED.
FOR CATALOGING DEPT. USE ONLY
LC/NUC OTHER ED.
5__ __
NUC DATE
L. C. CARD NO.
001
6__ __
7__ __
8__ __
ENCUMBRANCES
1 2 3 4 5 6
BO AV MS S I M
B/H
LO
G
INVOICE NO.
INVOICE DATE
COST
AQ2 REV. 1-73
CORNELL UNIVERSITY LIBRARIES ITHACA, N.Y.
TYPE
LANG.
IN
REC. SAV.
TERMINAL NOTES:
FORM
BIBL LVL.
DIFF
REC. PROD.

Figure B-1

Abbreviations and Terms:

For. Cur.--foreign currency

Sequence No.--Number assigned by keypunchers

Account No.--fund to which cost of book should be charged

Source--bibliographical reference from which searching information was taken

B/H--book in hand

POS--part of series; used to indicate that library wants to order volume separately

LO--letter order

F-D--foreign or domestic; used for book order statistics

RUSH--book must be rushed through processing

RARE--book to be rushed and treated with special care

A--order anyway; used when requester wants to acquire a book, regardless of presence elsewhere on campus

NST
KARDEX
ULS
CUL
OC
STL
LC
IN
} Files and Reference Tools

Other Ed.--call numbers for other edition in library system

Same Ed.--call number for same edition, added serial volume or multi-volume work

NUC Date--date of volume in which National Union Catalog information was found

Notify/Date--requester's name and department

Encumbrances

1) BO--blanket order

2) AV--added volume

3) MS--monographic series

4) S--serials

5) E--exchange sent

6) M--memberships

OCLC fixed fields

Type, Lang (language), Form, Bibl Lvl (bibliographic level), Intel Lvl (intelligence level)

IN--copy in OCLC data base

DIFF--copy for different edition in OCLC

REC SAV--record saved

REC PROD--record revised and produced

OCLC Call No.--number as cataloged in OCLC system

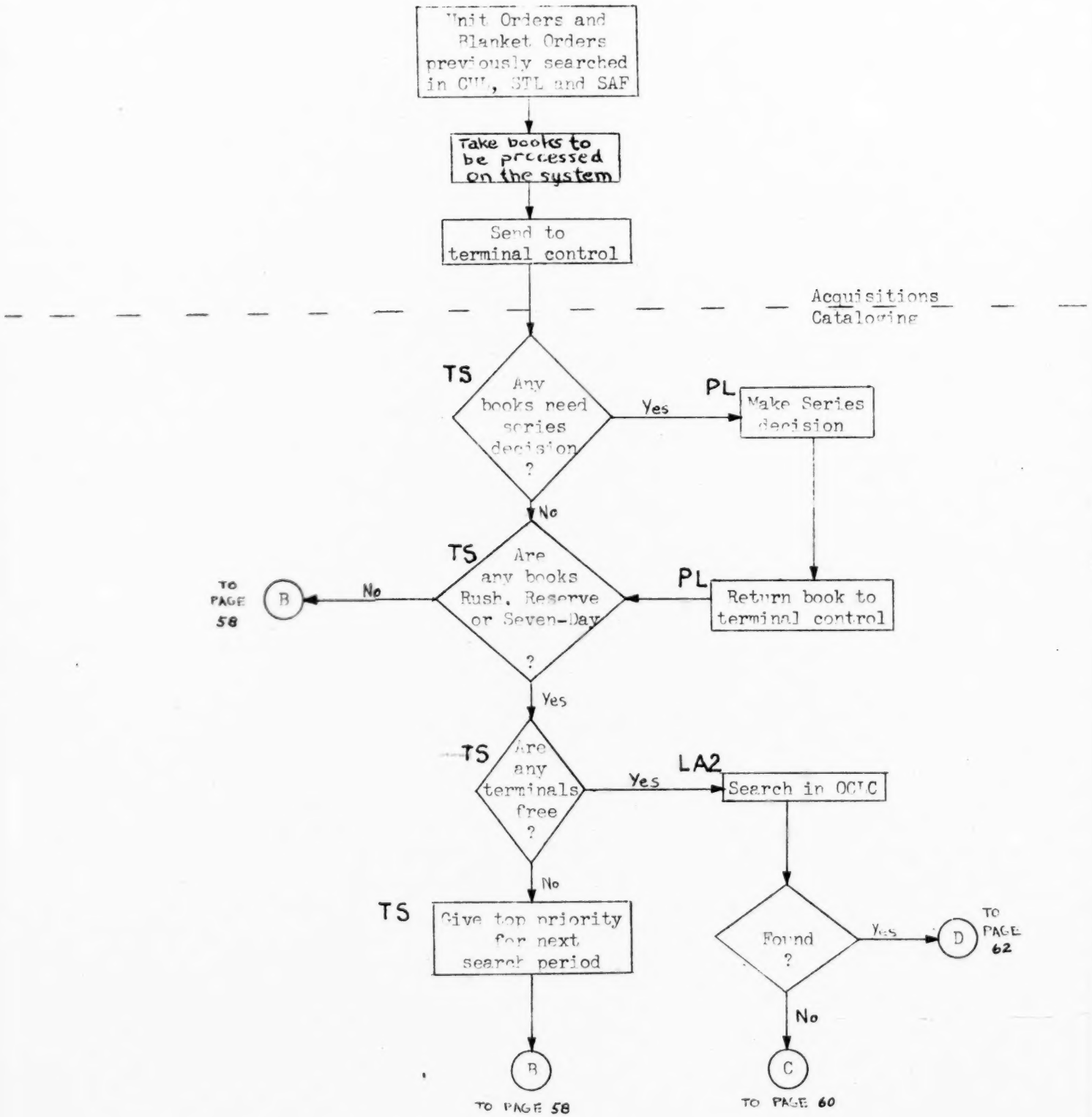
Appendix B-4

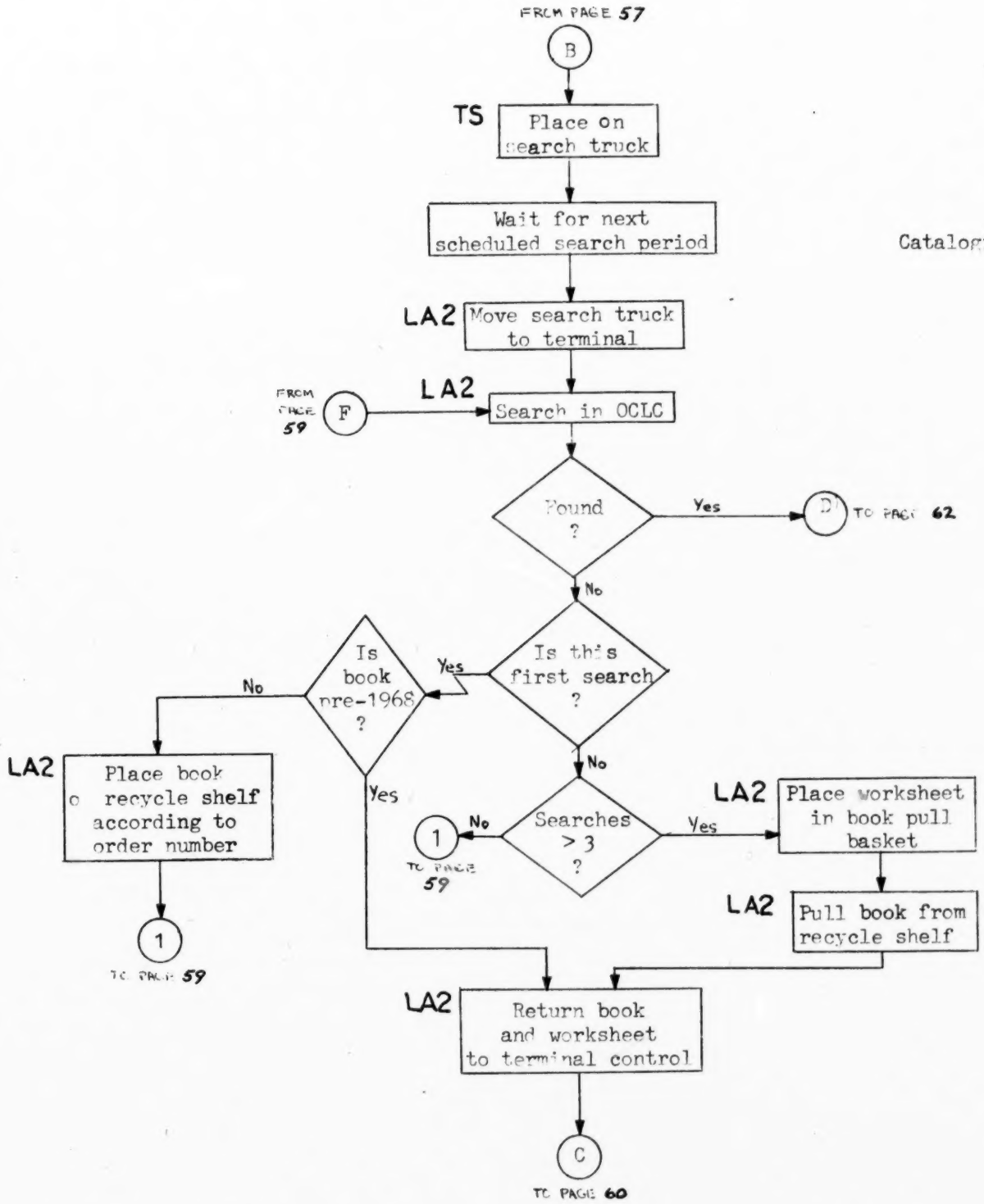
Workflow Chart for the Proposed System

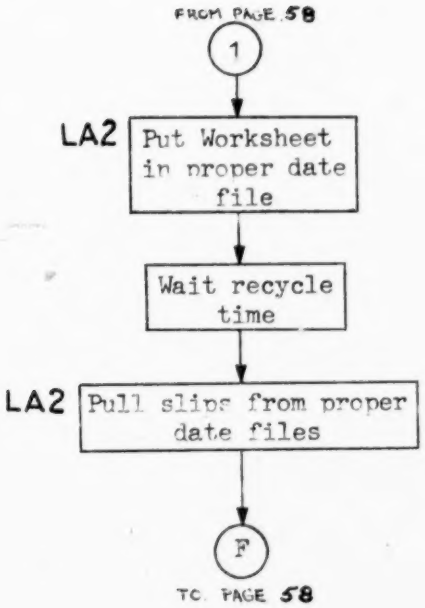
The flowchart on the following pages indicates the paths to be taken by material when being processed on the computer-based cataloging system. Once terminals are installed in Olin Library, all English language titles, with the exception of rare books, will be processed through the system. Once control is acheived for this mode of operation, Romance and Germanic titles can be added to the processing load.

The flowchart illustrates variation in present activities in the Acquisitions, Cataloging and Catalog Maintenance departments in conjunction with processing via the terminal system. To the left of many of the activity and decision blocks is an abbreviation referring to the job level requirement assigned to the activity or necessary to make the decision. The four job classes are as follows:

Library Assistant II	LA2
Library Assistant III	LA3
Professional Librarian	PL
Terminal Supervisor	TS

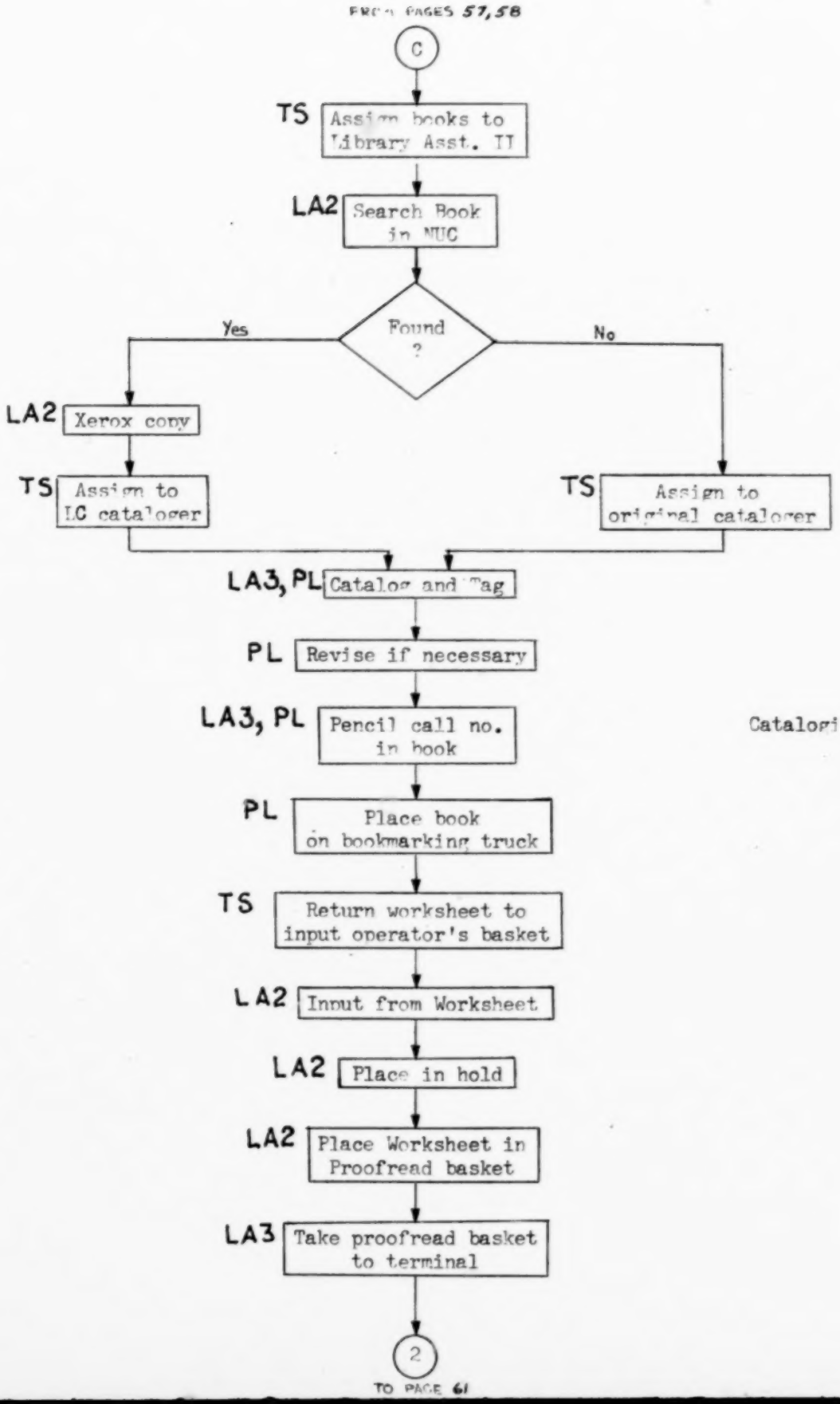

Unit Orders and Blanket Orders previously searched in CUL, STL and SAF
Take books to be processed on the system
Send to terminal control
Acquisitions
Cataloging
TS
Any books need series decision ?
Yes
PL
Make Series decision
No
TS
Are any books Rush, Reserve or Seven-Day ?
No
TO PAGE 58
B
PL
Return book to terminal control
Yes
TS
Are any terminals free ?
Yes
LA2
Search in OCLC
No
TS
Give top priority for next search period
Found ?
Yes
D
TO PAGE 62
No
B
TO PAGE 58
C
TO PAGE 60


FROM PAGE 57
B
TS
Place on search truck
Wait for next scheduled search period
LA2
Move search truck to terminal
FROM PAGE 59
F
LA2
Search in OCLC
Found ?
Yes
D
TO PAGE 62
No
Is this first search ?
Yes
Is book pre-1968 ?
No
LA2
Place book o recycle shelf according to order number
1
TO PAGE 59
Yes
No
1
TO PAGE 59
Searches > 3 ?
Yes
LA2
Place worksheet in book pull basket
LA2
Pull book from recycle shelf
LA2
Return book and worksheet to terminal control
C
TO PAGE 60


FROM PAGE 58
1
LA2
Put Worksheet in proper date file
Wait recycle time
LA2
Pull slips from proper date files
F
TO PAGE 58

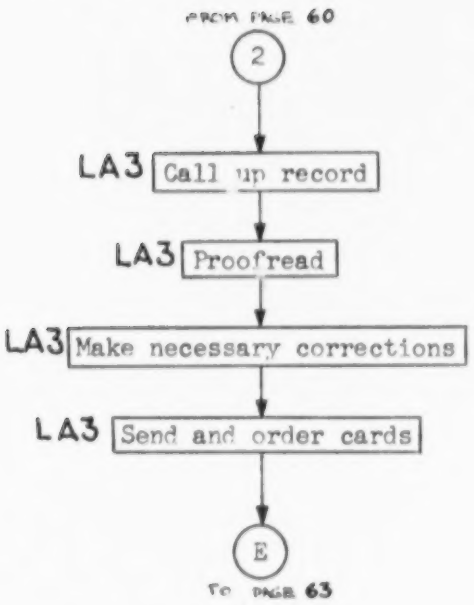
Cataloging

FROM PAGES 57,58

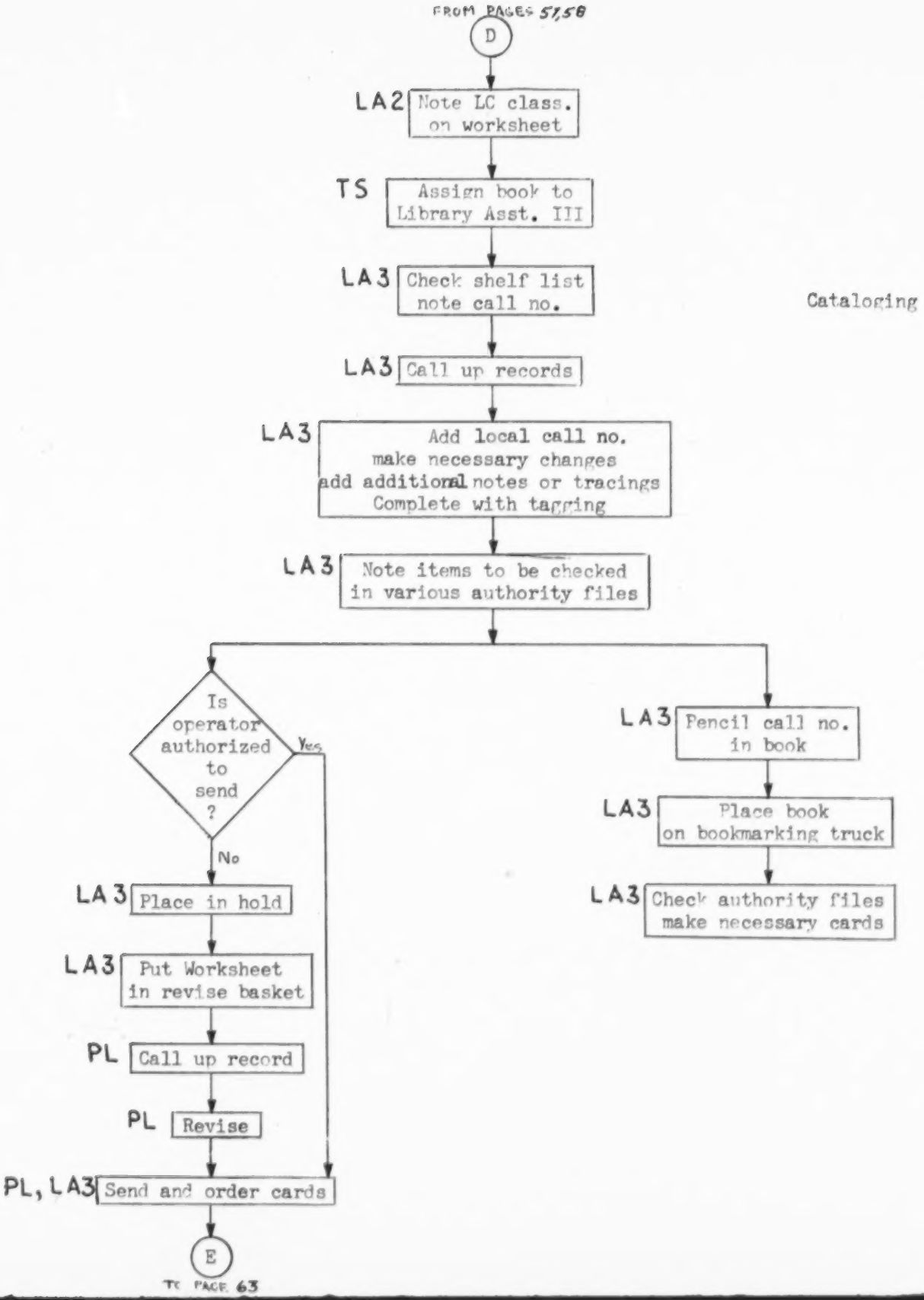


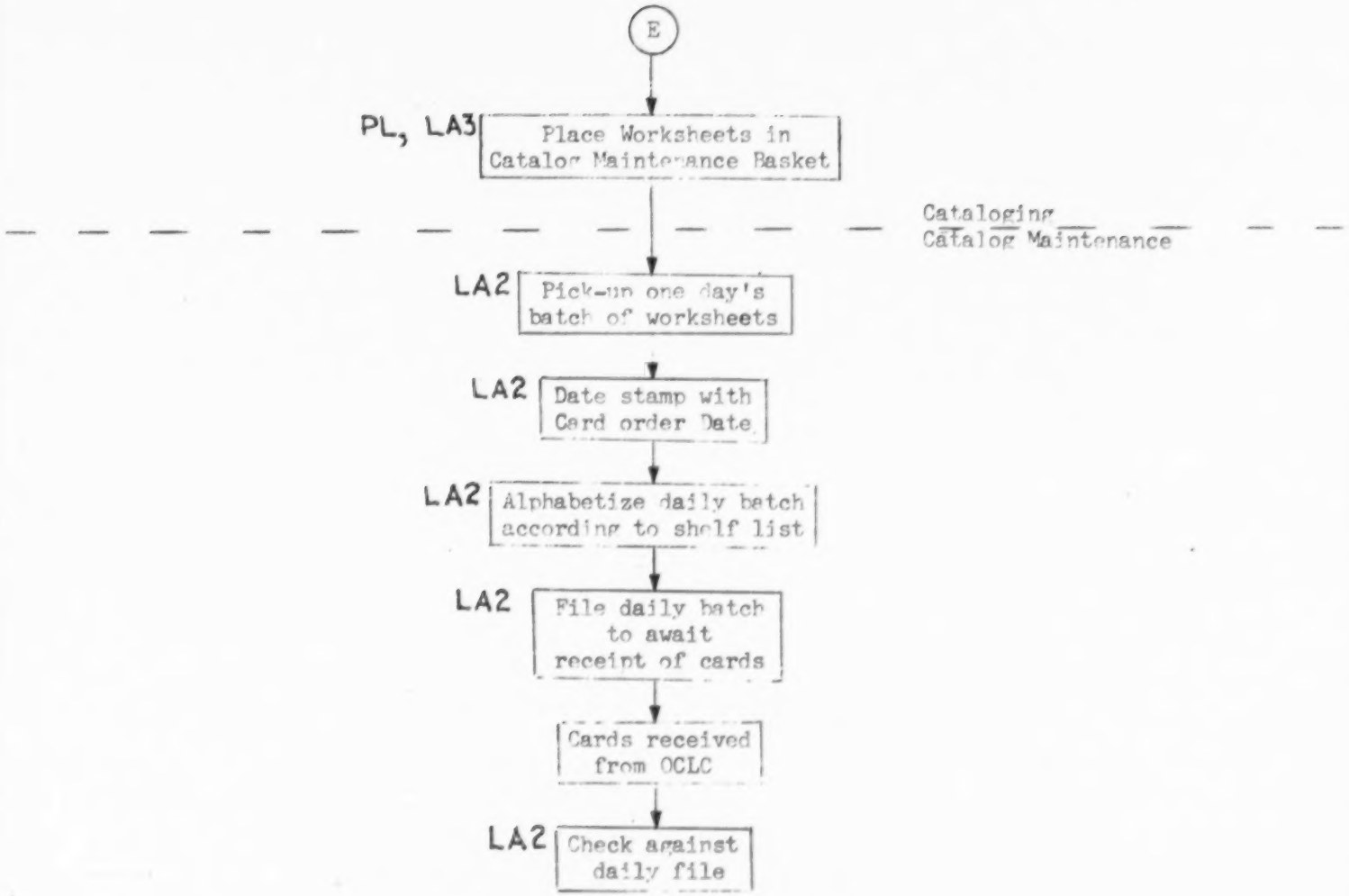
Cataloging

TO PAGE 61


FROM PAGE 60
2
LA3 Call up record
LA3 Proofread
LA3 Make necessary corrections
LA3 Send and order cards
E
TO PAGE 63

Cataloging


FROM PAGES 57,58
D
LA2
Note LC class. on worksheet
TS
Assign book to Library Asst. III
LA3
Check shelf list note call no.
LA3
Call up records
LA3
Add local call no. make necessary changes add additional notes or tracings Complete with tagging
LA3
Note items to be checked in various authority files
Is operator authorized to send ?
Yes
No
LA3
Pencil call no. in book
LA3
Place book on bookmarking truck
LA3
Check authority files make necessary cards
LA3
Place in hold
LA3
Put Worksheet in revise basket
PL
Call up record
PL
Revise
PL, LA3
Send and order cards
E
TO PAGE 63


E
PL, LA3
Place Worksheets in Catalog Maintenance Basket
Cataloging
Catalog Maintenance
LA2
Pick-up one day's batch of worksheets
LA2
Date stamp with Card order Date
LA2
Alphabetize daily batch according to shelf list
LA2
File daily batch to await receipt of cards
Cards received from OCLC
LA2
Check against daily file

Appendix B-5

Scheduling of the Terminals

Scheduling of the terminals should allocate enough time for each of the terminal functions. The scheduling should be flexible enough to allow for any changes in work loads. Time for training on the terminals should also be considered.

The following table shows the proper allocation with and without training:

Function	Required Yearly hours	percentages without	with
Input	1900	26.6	25.5
Search	2500	35.0	33.6
Catalog	1800	25.2	24.2
Proofreading	950	13.2	12.8
Training	(300)	___	3.9
Total		100.0	100.0

For three terminals there are 36 effective working hours per day. Scheduling should be based on these percentages.

	WITHOUT TRAINING		WITH TRAINING	
Function	hours/day	whole hours/day	hours/day	whole hours/day
Input	9.6	10	9.2	9
Search	12.6	12	12.1	12
Cataloging	9.1	9	8.7	9
Proofreading	4.7	5	4.6	5
Training	___	___	1.4	1
	36.0	36	36.0	36

Appendix B-6

Recycling Policy

Since information about every title is not contained in the data base, there is a possibility of not finding the desired information on the title. There is also a possibility that the title will eventually be added to the data base by another source (another library or the Library of Congress). Recycling involves subsequent checks of the data base to find titles that have been added to the data base.

Since OCLC receives MARC tape updates from the Library of Congress weekly, inter-search times should be greater than or equal to one week to allow for the inclusion of all LC titles. Some libraries use four or five searches. For example, Dartmouth College searches monthly for six months and then once more after another six month duration. After three searches (allowing adequate time between searches) the percentage of remaining titles found is very small. For Cornell a policy that uses at most three searches, with searches separated by two weeks, is recommended. More searches may find a few more titles but will increase the average cataloging time per title. Using this policy the library should expect to find seventy percent of the titles in the data base.

Appendix B-7

Annual Cost of Proposed System

I. Equipment		
A. Terminal Leasing	3 at 1200/terminal	¢ 3,600
B. OCLC Charge	27,000 at .78/wt'd title[1]	21,060
C. Card Production	46,000 at 31.5/card set	14,490
D. Servicing	3 at 360/terminal	1,080
E. Telephone Line Charge		2,736
F. Data Set	3 at 660/terminal	1,980
G. Conditioner		336
H. Telephone Equipment		462
		¢ 45,744
II. Labor		
Labor Cost	40,000 at .90/title	¢ 36,000
III. Total		
Total Annual Expected Cost		¢ 81,744

IV. Installation

The initial investment in chairs, tables, worksheets, and the installation of the terminals will come to approximately ¢2,000. This can be converted from a present value to an annual cost but the contribution is negligible and will not be considered.

[1]The weighted title charge is a basis for distributing the OCLC cost fairly among member libraries. It is obtained by multiplying the percentage of titles extracted from existing records by the total number of titles cataloged on the system. Present indications put this cost at ¢.78 per title. Cornell will have 40,000 x .67 = 27,000.

Appendix B-8

Processing Time of the Proposed System

The processing time is the amount of time required to put the book on the shelf and file the cataloging cards.

Assumptions:

1) 55% of titles found in first search.
2) 15% found in remaining searches.
3) Searches made every two weeks.
4) Cards are delivered one week after the titles are put on the system.
5) Cards are filed in one week.

Titles	E(Time)	Total
55%	2 weeks	1.1
15%	6 weeks	.9
30%	8 weeks	2.4
		4.4

Expected process time is 4.4 weeks/title.